Mo., to Cairo, it became so heavy from the 27th to the 31st, inclusive, that it seriously interfered with, but not entirely ended, steamboat traffic.

No ice was observed below New Madrid, Mo., 70 miles below Cairo.

The Missouri River closed at Pierre, S. Dak., on the 4th, and at the end of the month the ice was 15 inches in thickness.

It closed at Omaha, Nebr., on the same date, nine days earlier than in December, 1901. In that portion of the river within the State of Missouri the ice was somewhat later. Navigation at Hermann, Mo., was not suspended until the 26th, whereas in December, 1901, the river at that place was closed on the 19th.

The James River, Dakota, was closed during the entire month, while the Red River of the North, at Moorhead, Minn., was three days later in freezing from bank to bank. At the close of the month there were 18 inches of ice at Moorhead.

Ice was reported in the Ohio River as far as Portsmouth, Ohio, but there was none of consequence in the tributaries, except the Allegheny and those within the State of Ohio.

The rivers of Maine and the Merrimac and upper Connecticut closed for the season from the 5th to the 8th, and the ice at Concord, N. H., on the Merrimac River, was 7 inches in thickness on the last day of the month.

Navigation on the Hudson River was suspended on the 8th, when the last through boat arrived at Albany, N. Y. Timely notice had been given that navigation would have to be suspended on that date. A gorge formed on the 18th at the Bath Pumping Station, just above Albany. Rain caused a breakup on the 21st, but as the ice passed down the river it again became jammed at the freight bridge at Albany, the jam extending to the bottom of the river. Various other gorges formed later in the month, but were devoid of unusual features.

There was plenty of ice in both branches of the Susquehanna River, but very little gorging or solid freezing as far as reported.

Some little ice was also noted in the Shenandoah and upper Potomac rivers.

The flood in the Red River continued during the month. The report on this flood will be published in the Annual Summary for 1902, lack of space preventing its appearance in this edition of the REVIEW.

The unusually heavy precipitation for the month also caused comparatively high water stages in the Ohio River, lower Mississippi, and the rivers of the Middle and South Atlantic States. At Cincinnati a flood tide from the Licking River caused a local rise of 12 feet from the 15th to the 16th, and a fleet of coal boats and barges was swept away, entailing a loss of $25,000. Warning had been given of the coming of this flood wave, for such it was, but the damage could not be prevented.

The Kentucky and Green rivers also discharged a large quantity of water at the same time, but no danger-line stages were reached except at Evansville, Ind., where the river was above the danger line of 35 feet from the 18th to the 26th, inclusive, with a crest stage of 40 feet on the 22d. Due warning was given of the approach of the high water, and no damage of consequence resulted beyond the flooding of some lowlands. In all, the property loss in the vicinity of Evansville was $1500, practically all of which might have been saved had the farmers heeded the warnings. In the vicinity of Mount Vernon, Ind., corn, cattle, and hogs, to the value of $25,000, were saved by the warnings, while at Shawneetown, Ill., the figures were much larger.

Moderately high stages in the South Atlantic States were preceded by the usual warnings, and nothing of unusual interest occurred.

The rivers of the Pacific coast changed but little, with the exception of the Willamette, which rose considerably during the first decade of the month on account of the excessive rains of that period. At Albany, Oreg., the maximum stage was 24.5 feet, 4.5 feet above the danger line, but farther down the river the rise was not so pronounced.

The highest and lowest water, mean stage, and monthly range at 156 river stations are given in Table VII. Hydrographs for typical points on seven principal rivers are shown on Chart V. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.—*H. C. Frankenfield, Forecast Official.*

CLIMATE AND CROP SERVICE.

By JAMES BERRY, Chief of Climate and Crop Service Divison.

The following summaries relating to the general weather and crop conditions during December are furnished by the directors of the respective sections of the Climate and Crop Service of the Weather Bureau:

Alabama.—First two weeks favorable for plowing. Very general and heavy to excessive rains during middle of month suspended farm work. Temperature averaged nearly normal until the night of the 25-26th, when a decided fall of temperature swept over the entire State, lasting through the 28th, giving temperatures as low as 8° in northern counties, doing no material damage to wheat and oats, which were doing well. Winter gardens in southern counties not seriously damaged. Some trucking land being prepared.—*F. P. Chaffee.*

Arkansas.—Frequent rains and damp weather retarded picking late maturing cotton, arrested its development, and injured the quality. Too wet for plowing or other farm work. Considerable corn in fields in northeast section; hauling and storing prevented by wet weather. Weather generally favorable for grain; the ground not frozen to any extent until the last week, when there were a few decidedly cold days. Early sown wheat and winter oats in good condition and doing well, but the weather was not favorable for sowing grain. Practically no preparations have been made for next season's crops.—*Edward B. Richards.*

Arizona.—The average temperature during December was slightly below normal, and the precipitation for the month was considerably in excess of the normal. The unusual amount of precipitation for November and December has been beneficial to ranges, and stock is generally doing well, ample feed being promised for the rest of the winter. Considerable grain has been sown and it is doing well. Seeding will continue during the coming month.—*M. E. Blystone.*

California.—The continued cold weather retarded the growth of grain and grass, but caused no material damage. Temperatures below freezing were frequent in nearly all parts of the State, but, as ample warnings were given to orange growers, the severe frosts caused but little injury to the fruit or young trees. Heavy rains in southern California were very beneficial to grain and grass. A large acreage of wheat is being sown.—*Alexander G. McAdie.*

Colorado.—For the mountain region as a whole the snowfall during October, November, and December has been less than normal, but as compared with the corresponding period last year there has been an excess, except on the watersheds of the Grand, White, Yampa, and North Platte. The general outlook for late irrigation, especially on the eastern and southern slopes, was much better than for several years.—*F. H. Brandenburg.*

Florida.—Conditions were most favorable until the middle of the third decade. On the 27th and 28th the weather became very cold, the line of freezing weather touching the northern limit of the southern district. Frost occurred over lowlands of the southern district some distance from the coast. Vegetables suffered throughout northern and central portions, and young citrus trees were slightly damaged. Some oranges in exposed places were frosted.—*A. J. Mitchell.*

Georgia.—The month was slightly colder than the average in north Georgia and warmer than the average in south Georgia. In the middle section nearly normal temperature prevailed. The coldest period was from the 26th to 28th, inclusive, when the minimum thermometer registered below 20° over the larger portion of the State. The general distribution of precipitation was irregular, particularly in the southern counties. The absence of extended cold weather during the month was favorable to fall sown wheat and oats, and no damage from winter killing was reported.—*J. B. Marbury.*

Idaho.—December was nearly normal as to temperature, but the precipitation was excessive. From the 1st to the 12th the precipitation was nearly continuous, but a delightful period of fair weather occurred from the 13th to the 20th, inclusive. The weather during the third decade was unsettled. Heavy snow fell on all the mountains and the winter stock ranges were more heavily covered than usual. Grazing animals suffered and many sheep died owing to scarcity of grass or failure of owners to provide other feed.—*S. M. Blandford.*

Illinois.—The weather was rather cold, but generally favorable to farm interests. The precipitation was sufficient and well distributed in the northern and central districts, but was very heavy in the southern. Wheat remained in a generally excellent condition, the damage by hessian fly being less than previously estimated. In the southern portion of the State the snow covering was insufficient, and there were some fears that injury to the wheat resulted from the severe cold during the latter half of the month. Rye remained in good condition.—*William G. Burns.*

Indiana.—Wet weather and soft ground prior to the last week retarded field work and at the end of the month considerable corn and fodder were yet in the open. Wheat sown before September 25 was badly damaged by flies and there was some complaint of too rank growth of later plantings, but the bulk of the wheat crop was in good condition. Pasturage was good up to the 24th, when a cold wave spread over the State, followed by snow, and dry feed became necessary for all live stock.—*W. T. Blythe.*

Iowa.—Snow, ice, and rain, followed by extreme cold in latter part of month, made it difficult to complete the corn harvest, which had been retarded by the wet fall. Generally, however, the snow was favorable for grass lands and facilitated the usual farm work of the season.—*John R. Sage.*

Kansas.—The weather was favorable to growing wheat and rye, and both were in good condition at the close of the month, though in the southeastern counties, in fields not well drained, the wheat was injured; in the central-southern counties the wheat was being pastured. Damp weather has retarded corn gathering and much remains in the fields.—*T. B. Jennings.*

Kentucky.—Wheat was in excellent condition at the close of the month. There was little snow protection during the cold spell of the last week, but wheat had such a good start that it was not injured. There is little complaint of fly. Rye and oats were in good condition. Corn gathering was retarded by heavy rains which flooded many fields; some corn was damaged. Tobacco stripping progressed well and is nearly completed. Stock was in good condition.—*S. P. Gresham.*

Louisiana.—A large acreage of sugar cane was standing at the opening of the month. An unusually early freeze occurred on the morning of the 5th, when the minimum temperatures in the sugar region ranged from 27° to 30°. Warnings of this freeze were issued on the 3d, forty hours before its occurrence, advising planters to protect cane, and thousands of acres, worth millions of dollars, were windrowed and protected. Grinding continued throughout the month with satisfactory results, and is well advanced. Winter gardens made good growth.—*I. M. Cline.*

Maryland and Delaware.—The wet weather of the month prevented general farm work, particularly corn husking and fodder hauling. Some damage was done by water in lowlands, but otherwise wheat was still promising, having had a snow cover during the coldest weather; the fly continued in the early sown wheat. Fall sown grasses were well set. Fruit and forest trees suffered injury from sleet storms, especially from those of the 13th and 15th.—*Oliver L. Fassig.*

Michigan.—The weather conditions during December were generally quite favorable to winter wheat and rye; the ground was fairly well covered with snow during the most critical times. Wheat went under snow in generally good condition; there was some freezing and thawing, but correspondents generally agreed that little, if any, damage had been done.—*C. F. Schneider.*

Minnesota.—There were minimum temperatures below zero in some parts of the State daily from the 3d to the 14th, and from the 22d to the 30th. The lowest temperatures occurred on the 8th, 25th, and 26th. All the lakes were closed by ice early in the month. The precipitation was nearly all snow, and good sleighing was general the whole month. No work in the soil was possible.—*T. S. Outram.*

Mississippi.—High temperatures were general on the 2d and 3d, followed by a cold wave on the 4th, with sleet and snow in the northern portion of the State. Another warm period prevailed from the 10th to the 15th, terminating in a general and excessive rain on the 15th. The 26th and 27th were the coldest days, when the temperature reached 24° on the Gulf coast.—*W. S. Belden.*

Missouri.—December was generally cloudy, with frequent rains and snows and considerable sleet. Up to the 24th wheat suffered little or no injury from unfavorable weather conditions. During the severe freezing weather from the 25th to the 28th the ground was bare and in some counties it was feared the crop had been damaged, but in most sections wheat was reported in good condition at the close of the month. The month was very unfavorable for corn gathering.—*A. E. Hackett.*

Montana.—The temperature was uniformly low; no extremely cold weather occurred except in the northeast part of the State, but the temperature was below normal, with few exceptions, throughout the month, and at numerous stations, situated in various parts of the territory to the east of the mountains, the mean temperature was lower than during any December since observations began. The precipitation was very much in excess of the normal, and a large number of stations report the greatest amount on record during any December. Snows were frequent and heavy in the main range of mountains, in Flathead County, and in the northeast section. In other parts of the State the fall, as a rule, ranged from normal to slightly above normal. All stock being fed and some losses were occurring in northeast Montana.—*Montrose W. Hayes.*

Nebraska.—The cold, cloudy weather of December, accompanied by the snow which came early in the month and covered the ground quite generally most of the month, rendered it a most unfavorable time for farm work. Corn husking progressed slowly and considerable corn was still in the field at the end of the month. The covering of snow was very beneficial to winter wheat. The wheat plant is small but healthy and strong.—*G. A. Loveland.*

Nevada.—The month was moderately mild and unusually dry. The last few days were quite cold and very favorable for harvesting the ice crop. The weather conditions were remarkably favorable to stock interests.—*J. H. Smith.*

New England.—December was an unusually severe month, the weather in many sections being the coldest on record for this month. The precipitation was largely in excess of the normal but well distributed and mostly in the form of snow.—*J. W. Smith.*

New Jersey.—A good blanket of snow covered the ground in all sections, except the extreme southern, from the 5th to 15th and from the 25th to 30th, affording good protection to winter grain and grass. These crops are in good condition; no heaving of the ground from thawing occurred. The average depth of snowfall for each section was: Northern, 19.5 inches; central, 13.4; southern-interior, 3.2; sea coast, 3.2—*Edward W. McGann.*

New Mexico.—Storm of the 13–14th covered the central plains and the mountain ranges with from a few inches to 2 feet of snow, which was of immense value, although some slight loss to stock resulted.—*R. M. Hardinge.*

New York.—The month was considerably colder than the average December, and the snowfall unusually heavy in most sections. The ground was well covered almost continuously, affording ample protection to winter wheat and rye, which crops were in excellent condition at the close of the month. General thawing conditions prevailed from the 19th to 22d, but an immediate fall of snow prevented serious damage from freezing.—*S. L. Mosby.*

North Carolina.—While in some sections there was too much rain, which interrupted late seeding, the abundant moisture brought up all wheat and oats sown before Christmas and enabled plants to become well rooted. Severe cold about the 27th and 28th checked wheat but did not materially injure it; there was no protective covering of snow. Some oats were mown on account of too forward growth. Both oats and wheat at the close of the month were in excellent condition. Complaints of damage by hessian fly are not especially numerous.—*C. F. von Herrmann.*

North Dakota.—The month was generally favorable for stock running on the range, as it was able to feed on the prairie most of the time. No severe storms or long cold periods prevailed during the month.—*B. H. Bronson.*

Ohio.—Wheat was generally well protected by snow during the coldest weather and was reported in excellent condition in all sections. In a few localities the hessian fly was reported in early sown wheat, but the affected areas were probably very small. There was considerable corn to be husked. Stock continues in good condition. At the close of the month the ground was covered with snow in all sections.—*J. Warren Smith.*

Oklahoma and Indian Territories.—Cloudy weather, frequent precipitation, and occasional sharp dips in temperature marked the first half of the month, and caused conditions that delayed the progress of farm work and prevented the picking of late cotton. The latter portion of the month was fair and almost ideal winter weather, and permitted the progress of work to some extent. Wheat and oats were in fine condition. Pasturage was good and stock was doing well. Late cotton was badly damaged by recent rains.—*C. M. Strong.*

Oregon.—The weather throughout the month was wet and generally unfavorable for farm work. In western Oregon early sown fall grain made slow growth, but was reported to be in a promising condition. In the Columbia River Valley the condition of the grain crop was more favorable. In that portion of the State there was considerable snow, which protected the young plants from cold and frost, and as the ground did not freeze beneath the snow no damage resulted.—*Edward A. Beals.*

Pennsylvania.—The conditions as a whole were favorable for grain, which was generally well protected by snow during the colder periods, and at the close of the month both wheat and rye were reported as in satisfactory condition.—*F. F. Townsend.*

Porto Rico.—Conditions favorable for all agricultural interests prevailed generally and all crops made good progress. Preparation of land and planting for gran cultura were carried on as far as practicable. A number of sugar mills began grinding during the month, but the results were generally unsatisfactory, because of the low density of the juice. Young tobacco was slightly injured early in the month by dry weather and later by heavy rains, but the tobacco crop is now promising. All remnants of coffee crop gathered and pruning of the trees commenced.

In the following table are given, for the various sections of the Climate and Crop Service of the Weather Bureau, the average temperature and rainfall, the stations reporting the highest and lowest temperatures with dates of occurrence, the stations reporting greatest and least monthly precipitation, and other data, as indicated by the several headings:

Summary of temperature and precipitation by sections, December, 1902.

Section.	Temperature—in degrees Fahrenheit.								Precipitation—in inches and hundredths.					
	Section average.	Departure from the normal.	Monthly extremes.						Section average.	Departure from the normal.	Greatest monthly.		Least monthly.	
			Station.	Highest.	Date.	Station.	Lowest.	Date.			Station.	Amount.	Station.	Amount.
Alabama	45.6	−1.1	Bermuda	78	11	Hamilton, Newburg.	8	27	5.77	+1.52	Letohatchie	9.20	Thomasville	2.50
			Valley Head		13									
Arizona	46.1	−0.5	Champies Camp	84	8	Fort Defiance	−16	16	1.71	+1.01	Pinal Ranch	4.62	Prescott	0.12
Arkansas	40.8	−1.9	Russellville	86	12	Oregon	5	26	5.71	+1.68	Marvell	10.20	Texarkana	2.80
California	46.6	−0.5	Elsinore	89	8	Bodie	−19	28	2.96	−0.88	Crescent City	17.29	Bishop	0.03
Colorado	25.6	−1.7	Las Animas	75	9	Gunnison	−35	30	0.98	+0.12	Ruby	5.11	Fruita	0.17
Florida	60.1	+0.9	Avon Park	92	15	De Funiak Springs	17	27	3.77	+1.15	Sumner	14.93	Jupiter	0.71
Georgia	47.3	+0.2	Waverly	83	2	3 stations	12	27, 28	4.53	+0.64	Quitman	11.34	Blakely	2.17
Idaho	27.7	−0.2	Hailey	65	1	Soldier	−25	14	2.48	+0.50	Murray	7.10	Blackfoot	0.10
Illinois	28.3	−2.1	New Burnside	66	11	Lanark	−13	8	3.08	+0.81	Raum	7.16	Antioch	0.70
Indiana	29.7	−2.1	Madison	62	2	Northfield	− 8	31	4.05	+1.34	Salem	7.25	Topeka	1.32
			Mount Vernon		11									
Iowa	20.1	−3.5	Albia	59	1	Estherville	−20	26	2.33	+0.85	Ridgeway	5.51	Ottumwa	0.67
Kansas	28.4	−5.0	McPherson	77	19	Garden City	−12	17	1.12	+0.22	Columbus	2.57	Viroqua	0.10
Kentucky	36.7	−0.7	Williamsburg	72	12	Scott	− 3	31	7.36	+3.83	Leitchfield	11.97	Pikeville	4.07
Louisiana	51.2	−0.8	Donaldsonville	82	14	Lake Providence	18	27	5.13	+0.80	Lawrence	8.13	Oxford	2.10
Maryland and Delaware	33.3	−1.7	Easton, Md.	70	22	Deerpark, Md.	− 4	10	6.00	+2.79	Sunnyside, Md.	8.63	Westernport, Md.	3.07
Michigan	24.1	−1.5	Charlotte	59	4	Thomaston	−15	12	2.28	+0.16	Calumet	4.59	Owosso	0.61
Minnesota	12.6	−3.3	Currie	45	2	Pokegama Falls	−45	26	1.79	+1.09	Grand Meadow / Mapleplain	3.19	Hallock	0.18
Mississippi	46.5	−1.7	Pearlington	80	3	Bipley	11	26, 27	5.68	+1.52	Austin	12.44	Indianola	3.90
Missouri	30.7	−2.4	Mount Vernon	68	1	Grant City	− 7	26	2.91	+0.71	Caruthersville	9.31	Carrollton	0.94
Montana	19.9	−4.6	Helena	58	9	Culbertson	−32	12	1.10	+0.38	Troy	5.81	Deer Lodge	0.06
Nebraska	21.2	−4.6	Loup	68	1	Lynch	−23	26	1.40	+0.70	Kennedy	2.80	Bluehill	0.35
Nevada	33.7	+3.2	Martins Ranch	78	25	Potts	− 2	3	0.35	−0.97	Lewers Ranch	2.79	5 stations	0.00
New England	23.0	−4.7	Provincetown, Mass.	61	1	Van Buren, Me.	−30	13	5.32	+1.81	Southington, Conn.	8.55	Cornwall, Vt.	1.44
New Jersey	31.7	−2.5	Indian Mills	62	3	Layton	−11	15	7.23	+3.65	Belvidere	8.99	Cape May City	5.81
New Mexico	34.4	+0.5	Carlsbad	82	5	Taos	− 9	15	1.03	+0.35	Fort Bayard	3.11	Olio	0.12
						Las Vegas		16						
New York	23.4	−3.6	Middletown	59	3	Axton	−30	9	4.20	+1.13	Wappingers Falls	9.25	Avon	1.40
North Carolina	41.8	−0.6	Sloan	76	3	Linville	0	28	3.87	+0.01	Horse Cove	8.84	Edenton	1.78
North Dakota	7.8	−4.9	Jamestown	49	19	McKinney	−35	25	0.51	+0.12	Portal	1.55	Minnewaukon	T.
Ohio	29.4	−2.7	Portsmouth	63	3	Garrettsville	−11	31	3.95	+1.32	Hanging Rock	6.38	Bucyrus	2.10
			Pipley		20	Orangeville								
Oklahoma and Indian Territories.	37.8	−2.3	Temple, Okla.	74	10	Kenton, Okla	4	16	2.09	+0.19	Goodwater, Ind. T.	4.86	2 stations	T.
Oregon	37.5	−0.2	Williams	70	9	Pine	−15	17	9.34	+2.88	Glenora	29.97	Umatilla	0.81
Pennsylvania	28.4	−3.3	Derry Station	68	3	Lawrenceville	−12	14	5.54	+2.48	Seisholtzville	8.51	Erie	1.97
Porto Rico	75.3	−0.3	Caguas	92	4	Barros	53	9	5.54	+0.68	San German	12.34	Guayamas	1.59
			Corozal		7									
South Carolina	46.8	+0.6	Selvern	85	19	Trial	10	28	4.26	+1.16	Conway	6.80	Bennettsville	1.92
South Dakota	13.9	−6.7	Fort Meade	70	10	Leola	−35	26	1.70	+1.14	Aberdeen	4.80	Grand River School	0.06
Tennessee	39.8	−0.1	Springdale	73	3	Liberty, Pope	5	27	6.49	+2.14	Kenton	10.53	Elizabethton	1.57
Texas	49.5	−1.1	Shaeffer Ranch	88	13	Mount Blanco	11	4	2.01	−0.20	Danevang	5.55	2 stations	0.00
Utah	26.9	−0.9	Hite	66	8	Loa	−25	14	0.89	+0.03	Ogden	2.11	Emery	T.
Virginia	37.9	−1.3	Boykins	72	11	Burkes Garden	3	27	3.69	+0.70	Ashland	5.94	Bristol	2.11
Washington	34.3	−1.5	Republic	64	26	Ellensburg	1	14	7.29	+1.83	Brinnon	22.45	Mottingers Ranch	1.01
West Virginia	33.9	−0.4	Williamson	70	21	Travellers Repose	− 2	31	5.33	+2.16	Pickens	9.95	Greensulphur Spr'gs	2.01
Wisconsin	17.6	−2.2	Prairie du Chien	60	21	Osceola	−28	8	2.23	+0.63	Prairie du Chien	3.37	North Crandon	0.65
Wyoming	23.5	−0.5	Fort Washakie	63	9	Border	−35	15, 16	0.96	+0.23	Rawlins	2.11	Basin	T.
			Thermopolis											

Gathering and shipping of the orange crop progressed actively, crop good. Other fruits and ground provisions generally plentiful. Pasturage good and abundant.—*E. C. Thompson.*

South Carolina.—With a mean temperature slightly above normal and no decided cold weather until near the end of the month, and with ample and well distributed rainfall, farm work, incidental to December, made favorable progress. Oats did well and look promising. Late cotton began to open after the freezing weather set in. Trucking interests were favored by the weather. Some progress made in preparing seed beds for tobacco.—*J. W. Bauer.*

South Dakota.—The weather averaged unusually cold. The precipitation, principally snow, averaged considerably above the normal, except over the extreme northwest portion of the State. During the latter part of the month the unmelted snow very materially interfered with the grazing of live stock on the ranges, there being from 6 to 16 inches of snow on the ground on the 31st over the greater portion of the middle and eastern sections of the State.—*S. W. Glenn.*

Tennessee.—The month was favorable to winter grains, and at the close conditions were, as a rule, much better and prospects much more encouraging than usual at this period. However, excessive rains in the western section did much injury to crops on lowlands. The cold weather of the latter portion of the month had rather a beneficial effect, by checking the hitherto rapid growth. Grains were generally well rooted.—*H. C. Bate.*

Texas.—Frequent rains retarded farming operations to a great extent on the 4th and 5th, although breaking land for next season's crops was in fair headway at the end of the month. Freezing weather prevailed in all parts of the State, except along the immediate coast. Wheat and other cereals made excellent progress, having suffered little or no injury from the moderate freezes, and except in scattered localities where minor damage had been done by green bugs, rust, and excessive precipitation, these crops were most promising. Some wheat was yet to be sown. Cutting and grinding of cane was completed.—*Edward H. Bowie.*

Utah.—The farm work of the month was generally confined to caring for the stock and hauling manure. Range feed was very scarce, and in parts of the southern section was covered by snow. Stock generally continues in fair condition. The month was favorable for fall grain.—*L. H. Murdoch.*

Virginia.—The general weather conditions of the month were not favorable for crop progress. There was an excess of cloudiness and moisture and a deficiency in temperature, hence the soil was cold and wet, and the growth of winter wheat, oats, and clover, and fall sown grasses was retarded. Rust appeared in some early sown fields of wheat and oats toward the latter part of the month, and some injury from hessian fly occurred in the southwestern part of the State. Late seeding has suffered no material damage as yet.—*Edward A. Evans.*

Washington.—Although the mean temperature was below normal, yet east of the Cascade Mountains it was mild and uniform. In the western district it was a very wet month, while east of the mountains there were frequent light snowfalls, which afforded a good covering for winter wheat, except in the central counties. There was not a large stand of winter wheat, but what came up was doing well under the snow. The unusual amount of moisture in the ground affords a splendid prospect for spring crops.—*G. N. Salisbury.*

West Virginia.—Wheat has not been more promising in a number of years, and very little complaint was made of damage by fly. No hard freezing weather occurred until after Christmas, and then there was enough snow for protection. Rye and oats were also in good condition, as well as stock. Feed was generally plentiful, but in some counties there will be a shortage. Farm work was well up to date and some plowing done in several southern counties.—*E. C. Vose.*

Wisconsin.—The month was marked by some extremely low tempera-

tures, especially in the northern sections. Heavy snows prevailed during the entire month and served as an excellent protection to grains and grasses, and their condition continues generally satisfactory. No reports of freezing have been made.—*J. W. Schaeffer.*

Wyoming.—No severe cold wave visited the State during the month and no destructive storm. Over the southeastern quarter of the State a severe storm prevailed on the 19th, but as the duration of the storm did not much exceed twenty-four hours and no cold weather accompanied it, the loss of stock was practically nothing. The snowfall of the month was very unevenly distributed over the State, the southeastern quarter receiving the greatest average.—*W. S. Palmer.*

SNOWFALL AND WATER SUPPLY IN THE ROCKY MOUNTAIN REGION.

The following extracts are taken from the snow bulletins for December, 1902, issued by the Climate and Crop Section Centers in the Rocky Mountain region:

Colorado.—For the mountain region, as a whole, the snowfall during October, November, and December has been less than normal; but as compared with the corresponding period last year there has been an excess, except on the watersheds of the Grand, White, Yampa and North Platte. Since the depths will be materially modified by the later snowfalls, the reports furnish no information as to what the water flow will be during the early part of the season. The general outlook for late irrigation, especially on the eastern and southern slopes, is much better than for several years.

Idaho.—The snowfall throughout the State during November and December has been heavy. In many sections it has been unprecedented. In a few localities it has been less than the average. Correspondents, with few exceptions, have had no hesitancy in estimating the prospective water flow for the coming crop season. Considering that the snowfall has been heavy and that in many sections it is packed and of icy character, the prospect for water is excellent without the aid of additional snow during January, February, and March.

Montana.—On the eastern slope of the Main Divide the snow was exceptionally heavy from the boundary line as far south as the Lewis and Clarke Pass; storms were frequent, and high winds drifted the snow in ravines to a depth of 50 feet in some places; these drifts are packed solid, but as no thaws have occurred they are not frozen throughout. To the immediate south of the Lewis and Clarke Pass the snows have not been so heavy; in the vicinity of Bald Butte, however, a large amount of snow is again encountered—packed drifts 25 feet in depth; about an equal fall occurred on the Missouri River side of the Main Divide in Silver Bow and Beaverhead counties, but there the winds have been light, and drifts are not general nor deep. In the mountains of Madison, Gallatin, and Park counties the fall has reached about an average, and in some localities it is a little less; it has drifted, but the drifts are not solid. In the Crazy, Big Belt, Little Belt, Highwood, and Snowy mountains the fall has been comparatively light and in some cases a little less than last year. Considering the visible supply of snow on December 31, its condition with relation to drifts, etc., and the state of the ground when the first snow fell, the conclusion is reached that the amount of conserved water very generally exceeds that at the same time last year; in Teton and northern Lewis and Clarke counties the amount will be much in excess of the average.

Nevada.—At the close of the month there was more snow on the mountains in the western part of the State than a year ago, while at the headwaters of the Humboldt River a large deficiency is reported. If average weather conditions prevail during the remainder of the winter the water flow during the coming season will probably be greater than during that of 1902.

Utah.—In all the watersheds the depth of snow in the mountains was greater at the close of December than it has been at the same time during the past three years. In the Great Salt Lake watershed the depth is about average, slightly above in the Sevier Lake watershed, and much above in the Green and Colorado rivers watersheds. The snow is fairly well drifted and very solid for this time of year. An abundant water supply for the coming crop season is already assured to the Green and Colorado rivers watersheds, and even if the precipitation be somewhat deficient during the rest of the snowfall season, a good supply may be expected in the Great Salt Lake and Sevier Lake watersheds.

Wyoming.—The storms of December over the southern half of the State increased the stock of snow, so that by the close of December about the usual depths were reported from the Laramie, Platte, Green, and Snake rivers watersheds. The snowfall over the eastern slope of the Big Horn Mountains has been very deficient; all reports from that section show that the stock of snow is at present decidedly deficient, one report stating that the present depth is the least known in that section at this season during the past ten years.

SPECIAL CONTRIBUTIONS.

STUDIES ON THE METEOROLOGICAL EFFECTS OF THE SOLAR AND TERRESTRIAL PHYSICAL PROCESSES.

By PROF. FRANK H. BIGELOW, U. S. Weather Bureau, dated December 28, 1902.

THE SEMIDIURNAL PERIODS IN THE EARTH'S ATMOSPHERE.

The double and the single diurnal periods.—The problem of accounting for the well known semidiurnal periods in the meteorological elements, barometric pressure, vapor tension or humidity, and electric potential, as observed at the surface of the earth, is still awaiting its complete solution, but since additional information on the subject has been obtained in the past few years through the different kinds of observations in the strata at higher levels above the ground, this is sufficient reason for bringing the subject before this section[1] of the American Association for the Advancement of Science. Fig. 1 shows the average curves deduced from the surface observations, as they have been repeatedly made in all parts of the tropical and temperate zones.[2]

There are two minima and two maxima, the first minimum at about 4 a. m., the second at about 4 p. m.; the first maximum at about 10 a. m., and the second at 8 to 10 p. m. If the sun is supposed to rise and set at 6 o'clock, this indicates that the diurnal atmospheric processes lag several hours behind the hour angle of the sun, just as the seasonal processes lag about forty or fifty days behind the annual temperature changes. Since this retardation occurs chiefly through the slow radiation and convection of the atmosphere, just as the annual temperature wave lags in penetrating the ground through its slow conduction, so therefore, these retardations in the diurnal elements may become the means of calculating the coefficients of conductivity and convection in the air. Now it is to be noted that while the pressure, vapor tension, and electric potential give a decided double period, the diurnal actinic radiation from the sun shows only a small midday depression, and the temperature none at all, for this is a curve with a single maximum at 3 p. m. and a minimum at 4 a. m. This suggests the problem to be resolved, namely, the occurrence of single and double diurnal periods at the same time in the lower strata of the atmosphere.

In past years, before it was recognized that the single period prevails throughout the atmosphere, except in its lowest layers, efforts were made to account for the surface double period in two ways: (1) by referring it to a dynamic forced wave involving the entire atmosphere, as was done by Lord Kelvin, and (2) by seeking to explore the possible connections between the observed waves and the manometric waves due to temperature effects in the lower strata. The first of these theories must be abandoned for weighty reasons: (1) because the double wave does not exist throughout the atmosphere, as has been stated, but is confined to the lowest strata; (2) because the double wave system breaks at the latitudes 60° north and south, and reappears in the polar zones at right angles to that system,[3] with a change in the phase of 90°; and (3) because there is no known physical principle requiring the existence of any semidiurnal forced wave system. The second theory is not satisfactory because it has been found impossible to establish any positive synchronism in its details between the temperature changes and the corresponding diurnal variations of pressure due to manometric heat effects. Dr. Julius Hann for years sought to explain the phenomena along these lines, but was obliged to abandon the attempt and to accept Lord

[1] Read before the Physics Section, B, of the American Association for the Advancement of Science at the Washington, D. C., meeting, December 28, 1902.

[2] Compare pages 120 and 121 of my paper, Eclipse Meteorology and Allied Problems, Weather Bureau Bulletin I, 1902.

[3] International Cloud Report, chapter 9.